

FORM PTO-1390 (REV. 5-93)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER 10191/899
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPLICATION NO. (If known, see 37 CFR 1.5)  <div style="font-size: 1.5em; font-weight: bold;">09/194773</div>
INTERNATIONAL APPLICATION NO. PCT/DE98/00525	INTERNATIONAL FILING DATE (21.02.98) 21 February 1998	PRIORITY DATES CLAIMED (04.04.97) 04 April 1997
TITLE OF INVENTION <b>METHOD FOR MANUFACTURING A SENSING ELEMENT</b>		
APPLICANT(S) FOR DO/EO/US <sup>3-00</sup> <sup>4-00</sup> <sup>5-00</sup> <b>GRASER, Theodor; JACH, Olaf; RENZ, Hans-Jörg; NEUMANN, Harald; and HANS, Anton</b>		
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information		
1. <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.		
2. <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.		
3. <input checked="" type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).		
4. <input type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date		
5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2))		
a. <input type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau).		
b. <input checked="" type="checkbox"/> has been transmitted by the International Bureau.		
c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US)		
6. <input checked="" type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)).		
7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))		
a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau).		
b. <input type="checkbox"/> have been transmitted by the International Bureau.		
c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.		
d. <input checked="" type="checkbox"/> have not been made and will not be made		
8. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).		
9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)) (unsigned).		
10. A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).		
<b>Items 11. to 16. below concern other document(s) or information included:</b>		
11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.		
12. An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.		
13. <input checked="" type="checkbox"/> A <b>FIRST</b> preliminary amendment.		
<input type="checkbox"/> A <b>SECOND</b> or <b>SUBSEQUENT</b> preliminary amendment		
14. <input type="checkbox"/> A substitute specification.		
15. <input type="checkbox"/> A change of power of attorney and/or address letter		
16. <input checked="" type="checkbox"/> Other items or information: Copies of International Search Report and Form PCT/RO/101.		

EXPRESS NO. EL169611821US

U.S. APPLICATION NO if known, see 37 C.F.R. § 1.5	INTERNATIONAL APPLICATION NO PCT/DE98/00525	ATTORNEY'S DOCKET NUMBER 10191/899
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<p>17. <input checked="" type="checkbox"/> The following fees are submitted:</p> <p><b>Basic National Fee (37 CFR 1.492(a)(1)-(5)):</b></p> <p>Search Report has been prepared by the EPO or JPO ..... \$930.00</p> <p>International preliminary examination fee paid to USPTO (37 CFR 1.482) . \$720.00</p> <p>No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) ..... \$750.00</p> <p>Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$1,070.00</p> <p>International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) ..... \$98.00</p>	<p><b>CALCULATIONS</b>      <b>PTO USE ONLY</b></p>
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ENTER APPROPRIATE BASIC FEE AMOUNT =	\$ 930	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	\$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	12 - 20 =	0	X \$22.00	\$ 0	
Independent Claims	1 - 3 =	0	X \$82.00	\$ 0	
Multiple dependent claim(s) (if applicable)			+ \$270.00	\$	
TOTAL OF ABOVE CALCULATIONS =				\$ 930	
Reduction by ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				\$	
SUBTOTAL =				\$ 930	
Processing fee of \$130.00 for furnishing the English translation later the <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				+	\$
TOTAL NATIONAL FEE =				\$ 930	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				+	\$
TOTAL FEES ENCLOSED =				\$ 930	

	Amount to be:	
	refunded	\$
	charged	\$

a. ☐ A check in the amount of \$\_\_\_\_\_ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No 11-0600 in the amount of **\$930.00** to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-0600. A duplicate copy of this sheet is enclosed.

**NOTE:** Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Kenyon & Kenyon  
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① *Richard L. Mayer*  
*Re No 35,932*  
*rice 2.07*

SIGNATURE

Richard L. Mayer, Reg. No. 22,490

NAME

12/2/98

DATE

63 Rec'd PCT/PTO 02 DEC 1998

EXPRESS MAIL CERTIFICATE

09/194773

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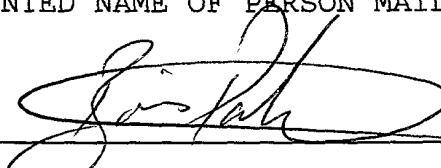
TYPE OF DOCUMENT PCT Nat'l Phase Pat/App. of Graser, et al.

SERIAL NO. \_\_\_\_\_ FILING DATE Herewith

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Method for Manufacturing a Sensing Element

65T 650 "E" 476160

09/194773

300 Rec'd PCT/PTO 02 DEC 1998

[10191/899]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s) : Theodor GRASER et al.  
Serial No. : To Be Assigned  
Filed : Herewith  
For : METHOD FOR MANUFACTURING A SENSING  
ELEMENT  
Examiner : To Be Assigned  
Art Unit : To Be Assigned

Assistant Commissioner  
for Patents  
Washington, D.C. 20231

PRELIMINARY AMENDMENT

SIR:

Kindly amend the above-identified application  
before examination, as set forth below.

IN THE SPECIFICATION:

Please amend the specification as follows.

On page 1, before line 1, insert:

--FIELD OF THE INVENTION--.

On page 1, line 1, before "invention" insert  
--present--.

On page 1, line 3, change "engines, having the" to  
--engines.--.

On page 1, delete line 4.

On page 1, delete line 6 and insert:  
--BACKGROUND INFORMATION--.

On page 1, line 8, change "The sensing" to --

ELI69611821US

Sensing--, and "for example, as so-called" to --for example as--.

On page 1, line 16, delete, "so-called".

On page 1, line 18, change "Known" to --Conventional--.

On page 1, line 19, change "can" to --may--.

On page 1, line 22, change "can" to --may--.

On page 2, line 13, delete "it is known, for example from".

On page 2, line 14, change "5, 144,249, to blunt" to --No. 5,144,249 describes blunting--.

On page 2, line 15, change "to equip" to --, equipping--.

On page 2, line 16, delete "after".

On page 2, line 17, delete "in".

On page 2, delete line 18, and insert --to subject completed sensing elements--.

On page 2, line 19, delete "subjected".

On page 2, line 20, change "can" to --may--.

On page 2, delete line 23, and insert:  
--SUMMARY OF THE INVENTION--.

On page 2, line 25, delete "having the".

On page 2, line 26, delete "features recited in Claim 1".

On page 2, line 27, change "can" to --may--.

On page 2, line 29, change "Because the" to --The--.

On page 3, line 1, after "sintering," insert --as a result,--.

On page 3, line 3, delete "a", and change "can" to --may--.

On page 3, line 16, change "can" to --may--.

On page 3, line 17, change "when" to --once the--.

On page 3, line 18, delete "already".

On page 3, line 24, change "can very advantageously be" to --may be advantageously--.

On page 3, line 27, delete "provision is moreover made for".

On page 3, line 28, change "to be" to --is--, and change "way" to --use--.

On page 3, delete line 29, and insert --treatment. Use of the laser treatment makes it possible to advantageously--.

On page 4, line 3, change "can" to --may--, and delete "Very".

On page 4, line 4, change "advantageously, it is possible to" to --It is possible to advantageously--.

On page 4, line 5, change "way of" to --using--.

On page 4, line 6, delete "that is preferably used".

On page 4, line 8, change "way of" to --using--, and "can" to --may--.

On page 4, line 11, change "can" to --may--.

On page 4, line 12, change "having" to --with--.

On page 4, line 13, change "can" to --may--.

On page 4, delete lines 22-29.

On page 5, delete lines 1-15, and insert:  
--BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a sectioned depiction through a sensing element.

Figure 2 shows a sectioned depiction through a panel of several sensing elements.

Figure 3 shows geometrical structures of lasers.

Figure 4 shows a use of a laser according to the present invention.

Figure 5 shows a use of a stamping technique according to the present invention.

Figure 6 shows a use of a stamping technique according to the present invention.

DETAILED DESCRIPTION--.

On page 5, line 18, change "can" to --may--.

On page 5, line 26, delete "the sectioned depiction shown in".

On page 6, line 22, change "having" to --have--.

On page 6, line 27, change "can" to --may--.

On page 7, line 4, change "known fashion" to --a conventional manner--.

On page 7, line 5, change "being" to --is--.

On page 7, line 6, change "optionally" to --optional--.

On page 7, line 13, delete "so-called".

On page 7, delete line 21, and insert --explained again.--.

On page 7, line 22, delete "for reasons of clarity."

On page 7, line 25, change "can" to --may--.



On page 7, line 26, change "can" to --may--.

On page 7, line 29, change "can" to --may--.

On page 8, line 3, change "can" to --may--.

On page 8, line 5, delete "Also conceivable are" and change "other" to --Other--.

On page 8, line 7, after "surfaces" insert --are also possible--.

On page 8, line 11, change "can" to --may--.

On page 8, line 12, change "can" to --may--.

On page 8, line 26, change "can" to --may--.

On page 9, line 8, change "latter" to --edges 36--.

On page 9, line 9, change "can" to --may--.

On page 9, line 11, change "can" to --may--.

On page 9, line 17, change "can" to --may--.

On page 9, line 23, change "can" to --may--.

On page 9, line 25, change "can" to --may--.

On page 10, line 1, change "can very" to --may--.

On page 10, line 3, change "can" to --may--.

On page 10, line 6, change "can" to --may--.

On page 10, line 7, change "can" to --may--.

On page 10, line 13, change "can" to --may--.

On page 10, line 17, change "all" to --sum--.

On page 10, line 19, change "can" to --may--.

**IN THE ABSTRACT:**

Please amend the Abstract as follows:

Delete line 1, and insert:

--  
                  ABSTRACT--.

Line 3, change "The invention concerns a" to  
--A--.

Line 4, after "element" insert --is provided--.

Line 8, after "blunted" insert --before sintering--.

Delete lines 12-15.

**IN THE CLAIMS:**

On page 1 of the claims, delete line 1, and  
insert:

--What Is Claimed Is--.

Please cancel claims 1-12, without prejudice.

Please add the following new claims.

13. (New) A method for manufacturing a sensing element for

determining oxygen content in exhaust gases of an internal combustion engine, comprising the steps of:

sintering at least one ceramic paste present in film form to yield the sensing element; and

blunting edges of the sensing element before sintering to increase a thermal shock resistance of the sensing element.

14. (New) The method according to claim 13, wherein the step of blunting includes the step of blunting the edges of the sensing element by shaping.

15. (New) The method according to claim 14, wherein the step of blunting the edges of the sensing element further includes the step of blunting the edges of the sensing element by stamping.

16. (New) The method according to claim 13, further comprising the step of:

introducing a profile into a stamping apparatus for pre-pressing a laminate construction of unsintered films of the sensing element.

17. (New) The method according to claim 16, further comprising the step of:

obtaining the profile by introducing a profiling film into the stamping apparatus.

18. (New) The method according to claim 17, wherein the step of blunting further includes the step of obtaining the profile by introducing profiling film having an anti-adhesion coating into the stamping apparatus.

19. (New) The method according to claim 13, wherein the step of blunting the edges of the sensing element further includes the step of blunting the edges of the sensing element using a laser treatment.

20. (New) The method according to claim 13, wherein the step of blunting includes the step of blunting the edges of the sensing element using an excimer laser having definable masking.

21. (New) The method according to claim 13, wherein the step of blunting includes the step of treating sectioned sensing elements with a laser, the sectioned sensing elements having a composition construction of green films.

22. (New) The method according to claim 21, further comprising the step of:

sectioning the sensing element from a wafer, the wafer including the sectioned sensing elements, wherein the treating step is performed prior to the sectioning step.

23. (New) The method according to claim 13, further comprising the step of:

sectioning the sensor element from a wafer with a laser, the wafer including individual sensing elements composed of a composite of green films, wherein the sectioning step is performed simultaneously with the blunting step, and wherein the blunting step includes the step of blunting the edges of the sensing element with the laser.

24. (New) The method according to claim 13, wherein the step of blunting further includes the step of producing a chamfer on the edges having at least one of a convex surface, a concave surface and a flat surface.

#### **Remarks**

This Preliminary Amendment cancels, without prejudice, claims 1-12 in the underlying PCT Application No. PCT/DE98/00525, and adds new claims 13-24. The new claims conform the claims to U.S. Patent and Trademark Office rules

and do not add new matter to the application.

The above amendments to the specification and abstract conform the specification and abstract to U.S. Patent and Trademark Office rules, and do not introduce new matter into the application.

The underlying PCT Application No. PCT/DE98/00525 includes an International Search Report, dated July 10, 1998. The Search Report includes a list of documents that were uncovered in the underlying PCT Application. A copy of the Search Report is included herewith.

It is respectfully submitted that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully submitted,

Dated: 12/2/98

By: *Richard L. Mayer*  
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[10191/899]

## METHOD FOR MANUFACTURING A SENSING ELEMENT

The invention relates to a method for manufacturing a sensing element, in particular for determining the oxygen content in exhaust gases of internal combustion engines, having the features recited in the preamble of Claim 1.

## Background Information

The sensing elements are configured, for example, as so-called planar sensing elements, which comprise a composite construction of individual layers arranged one above another in film form. The individual films of this composite construction are arranged one above another in defined fashion, resulting in various functional layers. The individual films of the composite construction are, for example, laid onto one another by means of a screen printing technique, as so-called green films. The sensing elements usually have solid electrolyte films, electrode films, heating conductor films, insulation films, and protective films. Known sensing films can also have substrate films with printed electrolyte layers, aluminum oxide substrate films with semiconductor sensors ( $\text{TiO}_2$ ,  $\text{SrTiO}_3$ ). Instead of laying the green films onto one another, the latter can also be obtained by individual printing steps. The arrangement of these

different films one above another results in a laminated composite construction from which the sensing element is obtained by sintering.

5 During testing of the sintered sensing element, or during utilization thereof as intended, the individual layers of the sensing element are exposed to different temperatures. Because of these sudden temperature changes which occur with differing intensity, the sensing elements experience a temperature shock  
10 which leads to the occurrence of mechanical stresses in the surface region, in particular at the edges of the sensing element. In order to increase the temperature shock resistance of the sensing elements, it is known, for example from U.S. Patent 5,144,249, to blunt the edges of the sensing element, i.e. to equip them with a chamfer. Chamfering is accomplished  
15 by way of a grinding operation after sintering and after sectioning of the sensing elements. It is disadvantageous in this context that the already complete sensing elements are subjected to a mechanical machining operation which is relatively complex and can lead to undesired damage to the  
20 sensing elements.

#### Summary of the Invention

25 The method according to the present invention having the features recited in Claim 1 offers, in contrast, the advantage that blunting of the edges of the sensing element can be accomplished in a simple manner without the risk of impairing the sensing element. Because the edges of the sensing element

are blunted prior to sintering, it is possible to blunt the edge in any desired geometry using simple, non-chip-removing methods. In particular, a blunting of the edges can be accomplished in a form deviating from a flat surface, for example in a convex or concave form, so that mechanical stresses which occur as a consequence of a temperature shock to the blunted edges cannot result in the creation of cracks.

In a preferred embodiment of the present invention, provision is made for the edges to be blunted by shaping, preferably by stamping of the film composite construction present in the green state. It is thereby possible, using a simple stamping tool, to shape the edges of the composite construction of green films in simple fashion, due to their soft consistency prior to sintering. By configuring a corresponding stamping tool, a blunting of the edges can be executed in any desired form. It is particularly advantageous if, when stamping tools have already been used, the stamping films laid in place are ones which allow shaping only of the edge region of the sensing element, and leave the other regions, in particular the planar regions of the sensing element, unmodified. In order to prevent adhesion of the green film composite construction of the sensing element in the stamping tool, the stamping film can very advantageously be equipped with an anti-adhesion coating, in particular Teflon.

In a preferred embodiment, provision is moreover made for blunting of the edges to be accomplished by way of a laser treatment. This makes it possible, very advantageously, to



accomplish noncontact blunting of the edges of the sensing element in the green state, so that any mechanical loads on the green film composite construction can be ruled out. Very advantageously, it is possible to adjust the contour of the blunted edges of the sensing element by way of a mask of an excimer laser that is preferably used.

By way of the laser treatment, blunting of the edges can preferably be accomplished even before sectioning of the green films present in the composite construction, so that blunting of the edges can be accomplished very effectively. At the same time, the break points of the wafer having the individual sensing elements can thereby be defined.

It is also preferred, in particular, if the laser treatment simultaneously accomplishes blunting of the edges and sectioning of the green film composite construction. By adjusting the laser output and the geometry of the laser beam, it is thus possible to accomplish edge blunting and sectioning in one operation.

Further advantageous embodiments of the invention are evident from the other features recited in the dependent claims.

#### Brief Description of the Drawings

The present invention will be explained in more detail below in exemplary embodiments, with reference to the pertinent drawings in which:

Figure 1 shows a sectioned depiction through a sensing element;

Figure 2 shows a sectioned depiction through a panel of several sensing elements;

Figure 3 shows geometrical structures of lasers;

Figure 4 shows the use according to the present invention of a laser; and

Figures 5 and 6 show the use according to the present invention of a stamping technique.

#### Detailed Description

Figure 1 shows a sectioned depiction through a sensing element 10 which can serve, for example, to determine an oxygen content in exhaust gases of internal combustion engines in motor vehicles or of furnaces. Since the configuration and function of a sensing element 10 of this kind are commonly known, only the configuration that is important for explaining the invention will be described below. The sensing element substantially has an elongated, flat-plate configuration that is composed of individual strata of various functional layers. As the sectioned depiction shown in Figure 1 illustrates, sensing element 10 possesses an electrochemical measurement cell 12 and a heating element 14. Measurement cell 12 includes a first solid electrolyte film 16 and a second solid

electrolyte film 18 which has an integrated reference gas conduit 20. A measurement electrode 22 is associated with a measured-gas-side surface of electrolyte film 16, and a reference electrode 24 is associated with the surface associated with reference gas conduit 20. A porous cover layer 26 is arranged above measurement electrode 22.

Heating element 14 has heating conductors 32 embedded in insulation layers 28 and 30. Adjacent to insulation layer 30 is a further cover layer 34.

Solid electrolyte films 16 and 18 and cover layer 34 are made, for example, of a stabilized zirconium oxide ( $ZrO_2$ ). Electrodes 22 and 24 and heating conductors 32 are made, for example, of a platinum cermet. Insulation layers 28 and 30 are made, for example, of a mixture of aluminum oxide ( $Al_2O_3$ ) and glass-forming components.

The entire composite construction of individual layers possesses, when viewed in cross section, an approximately parallelepipedal configuration, at least edges 36 running in the longitudinal direction of the sensing element having a chamfer 38.

Sensing element 10 is manufactured by successive lamination of the individual layers onto cover layer 34, which at the same time constitutes a support. Definition of the layers can be accomplished by screen printing of a paste material which has the respective composition of the layer. After completion of

this lamination, there results a composite construction of so-called green films of the individual layers, which possess a relatively soft consistency. The composite construction is then subjected in known fashion to a sintering operation, sensing element 10 being created under the action of temperature and optionally pressure.

According to the present invention, provision is now made, before sintering, for patterning chamfers 38 of edges 36. Individual possibilities for achieving chamfers 38 will be discussed below.

Figure 2 shows a portion of a so-called panel of a plurality of sensing elements 10 present in the green state. In this, the individual layers of sensing elements 10 are laminated simultaneously for a plurality of sensing elements 10, and the composite construction of green films for one sensing element 10 is then sectioned out. Figure 2 shows portions of three sensing elements 10. Parts identical to those in Figure 1 are given identical reference characters, and will not be explained again, detailed depiction being dispensed with here for reasons of clarity. After lamination, cutting lines 40 are defined at which sectioning of sensing elements 10 is accomplished. Prior to sectioning of sensing elements 10, a defined surface depression 42 can be introduced at cutting lines 40. This surface depression 42 can be executed, for example, using an excimer laser 44 which has a specific mask. Figure 3 shows, for example, two possible masks. According to the left-hand depiction, excimer laser 44 can possess a

triangular mask so that surface depressions 42 are triangular in accordance with this depression. According to the exemplary embodiment depicted on the right in Figure 3, the mask can also have delimiting surfaces extending in concave fashion.

Also conceivable are other exemplary embodiments which exhibit mixed forms of planes running at various angles and/or concave and/or convex delimiting surfaces.

As Figure 4 illustrates, excimer laser 44 is moved along the surface of the composite construction of green films. For this purpose, either excimer laser 44 can be movable, and/or the green films can be moved past excimer laser 44. Surface depression 42 is patterned in terms of its depth and feed rate in accordance with the output setting of excimer laser 44.

The patterning of surface depressions 42 yields blunted edges 36 with their chamfers 38. Sensing elements 10 are then sectioned along cutting lines 40, and are then subjected to the sintering operation. Sensing element 10 shown in cross section in Figure 1 is then created. Because chamfers 38 are patterned while the films of sensing element 10 are in the green state, and because of the noncontact patterning with excimer laser 44, sensing element 10 is not subjected to any mechanical stress, thus substantially ruling out damage.

Sectioning of the sensing elements can be accomplished via a further treatment with an excimer laser which has a corresponding mask. It is also possible, however, by selecting a mask and an output level for excimer laser 44, to execute

the surface depression and sectioning in one operation.

Figure 5 indicates a further possibility for patterning chamfers 38. In this, a sensing element 10 is acted upon by a stamping apparatus 45 after sectioning of the composite construction of green films. Stamping apparatus 45 possesses a contour 46 which allows shaping of edges 36 in such a way that the latter then exhibit chamfers 38. Depending on the shaping of contour 46, chamfer 38 can also have a different contour as a result of stamping, for example planar and/or convex and/or concave sections. Contour 46 of stamping apparatus 45 can be created either by manufacturing a corresponding stamping apparatus 45, or by laying a stamping film 48 into stamping apparatus 45. Stamping film 48 is preferably equipped with an anti-adhesion coating, for example Teflon or titanium nitride. Since the green films still have a relatively soft consistency in the case of this shaping as well, chamfers 38 can easily be stamped in without causing impairment to the prefabricated sensing element 10.

Figure 6 shows a further exemplary embodiment in which stamping of a composite construction of sensing elements 10 can be accomplished. For this, stamping apparatus 45 possesses a stamping contour 50 which exhibits projections 52 corresponding to depressions 42. Stamping contour 50 can also be equipped with an anti-adhesion coating. With the exemplary embodiment shown in Figure 6, it is easy to stamp a plurality of sensing elements 10 in a multiple panel with one stamping step, subsequent sectioning occurring along cutting lines 40.

Stamping apparatus 45 can very advantageously have an upper die 54 and a lower die 56, so that the upper and lower sides of sensing elements 10 can be stamped simultaneously in one process step. Because of the relatively soft consistency of the as-yet unsintered sensing elements 10, surface depressions 42 can be stamped in with little energy expenditure, so that damage to the structure of sensing elements 10 can be excluded.

It is self-evident that when chamfers 38 are patterned either using excimer laser 44 or with stamping apparatus 45, both sides of sensing element 10 are processed. For this purpose, either an apparatus acting in double-sided fashion can be provided, or the green film composite construction of sensing elements 10 is turned over.

In all, it is clear that the configuration of chamfers 38 in various contours, which is desirable in order to increase the temperature shock resistance of sensing element 10, can be effected using easily implemented actions. The outlay for tooling is relatively low, and the latter is subject essentially to no wear, so that long service lives may be expected. The additional use of consumable materials, for example as in the case of grinding of the sintered sensing element 10 defined in the existing art, is entirely eliminated.

## Claims

1. A method for manufacturing a sensing element, in particular for determining the oxygen content in exhaust gases of internal combustion engines, a composite construction comprising at least one ceramic paste (green film) present in film form being sintered to yield the sensing element, and sharp edges of the sensing element being blunted to increase the thermal shock resistance of the sensing element, wherein the edges (36) of the sensing element (10) are blunted before sintering.

2. The method as defined in Claim 1, wherein the edges (36) are blunted by shaping.

3. The method as defined in Claim 2, wherein the edges (36) are blunted by stamping.

4. The method as defined in one of the foregoing claims, wherein a profile (46) is introduced into a stamping apparatus (45) for pre-pressing a laminate composite construction of unsintered films of the sensing element (10).

5. The method as defined in Claim 4, wherein the profile (46) is attained by way of a profiling film (48) introduced into the stamping apparatus (45).

6. The method as defined in Claim 5, wherein the profiling film (48) is equipped with an anti-adhesion coating.



7. The method as defined in Claim 1, wherein the edges (36) are blunted by way of a laser treatment.

8. The method as defined in Claim 7, wherein an excimer laser (44) with definable masking is used for the laser treatment.

9. The method as defined in one of the foregoing claims, wherein the laser treatment is performed on sectioned sensing elements (10) that are present as a composite construction of green films.

10. The method as defined in one of the foregoing claims, wherein the laser treatment for blunting the edges (36) is accomplished prior to sectioning from a wafer of sensing elements (10) that are present as a composite construction of green films.

11. The method as defined in one of the foregoing claims, wherein the laser treatment is used simultaneously to section from a wafer individual sensing elements (10) present as a composite construction of green films, and to blunt the edges (36).

12. The method as defined in one of the foregoing claims, wherein the chamfers (38) of the edges (36) possess a convex and/or concave and/or flat surface.

Abstract of the Disclosure

The invention concerns a method for manufacturing a sensing  
element, in particular for determining the oxygen content in  
5 exhaust gases of internal combustion engines, a composite  
construction having at least one ceramic paste (green film)  
present in film form being sintered to yield the sensing  
element, and sharp edges of the sensing element being blunted  
to increase the thermal shock resistance of the sensing  
10 element.

Provision is made for the edges (36) of the sensing element  
(10) to be blunted before sintering.

(Figure 1)

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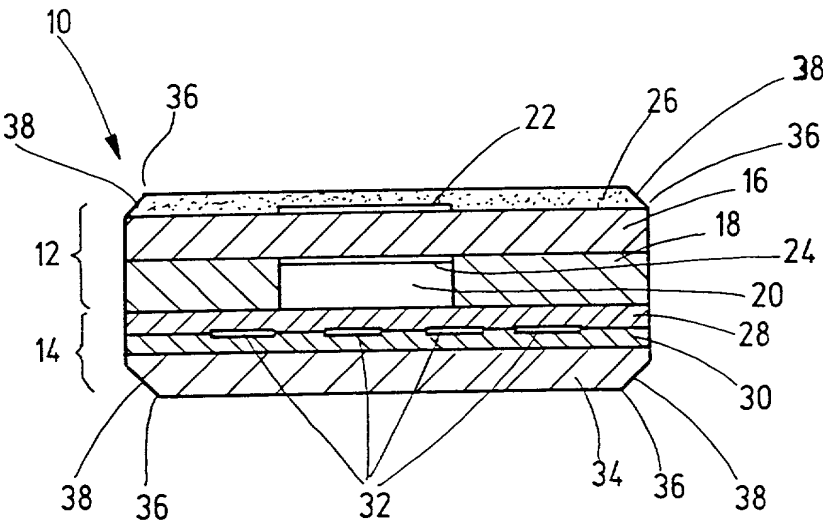


Fig. 1

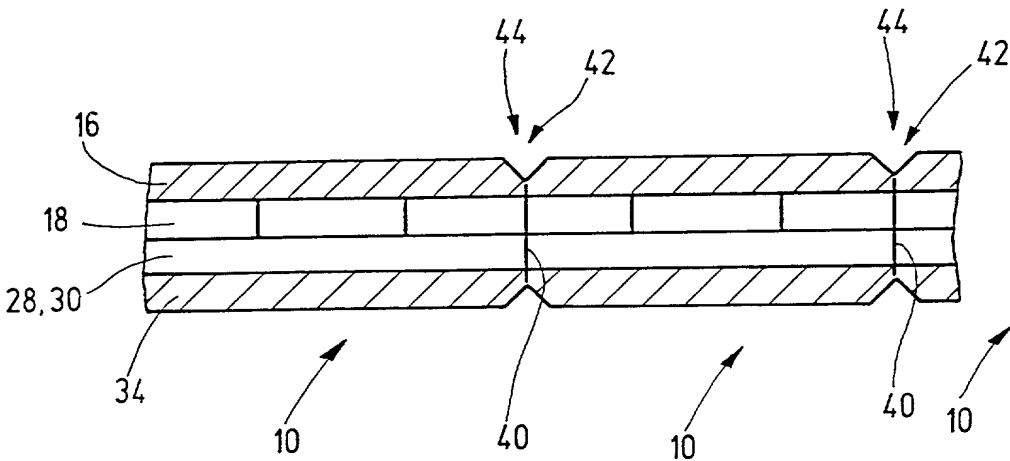


Fig. 2

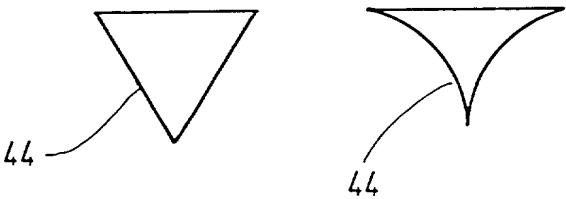
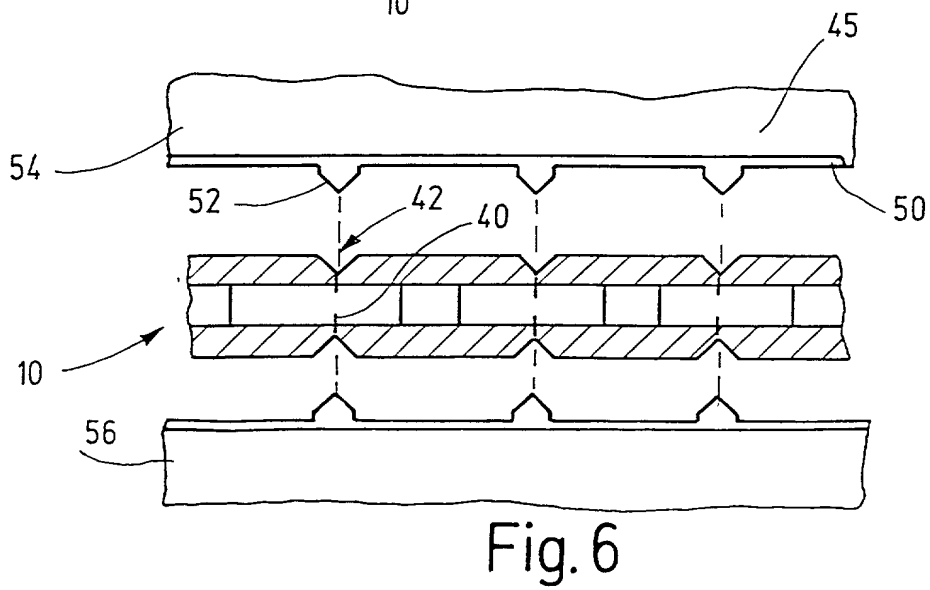
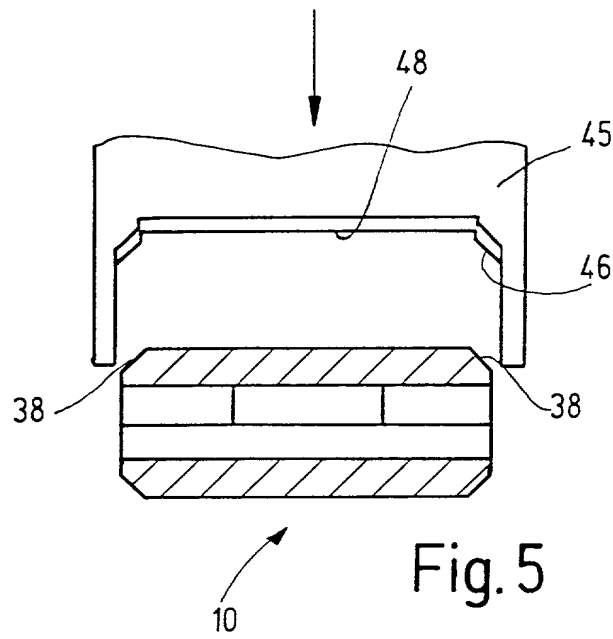
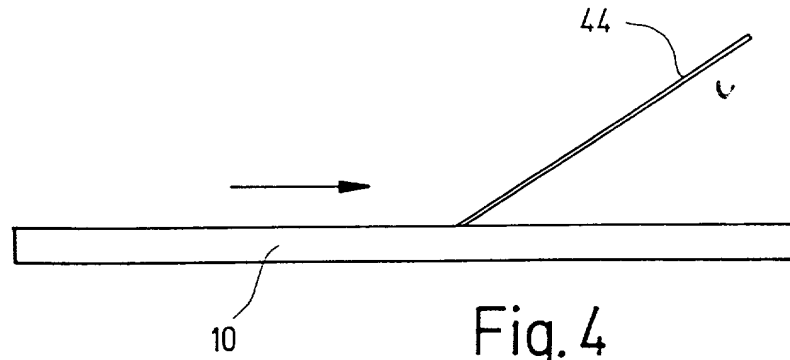


Fig. 3



**COMBINED DECLARATION AND  
POWER OF ATTORNEY FOR PATENT APPLICATION**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below adjacent to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **METHOD FOR MANUFACTURING A SENSING ELEMENT**, and the specification of which:

- ☐ is attached hereto;
- ☐ was filed as United States Application Serial No. \_\_\_\_\_ on \_\_\_\_\_, 19\_\_ and was amended by the Preliminary Amendment filed on \_\_\_\_\_, 19\_\_.
- ☒ was filed as PCT International Application Number PCT/DE98/00525, on the 21st day of February, 1998
- ☒ an English translation of which is filed herewith.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a). I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

**PRIOR FOREIGN/PCT APPLICATION(S)  
AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119**

Country : Federal Republic of Germany

Application No. : 197 13 904.3

Date of Filing: April 4, 1997

Priority Claimed

Under 35 U.S.C. § 119 : ☒ Yes ☐ No

I hereby claim the benefit under Title 35, United States Code § 120 of any United States Application or PCT International Application designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations § 1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

**PRIOR U.S. APPLICATIONS OR  
PCT INTERNATIONAL APPLICATIONS  
DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. § 120**

U.S. APPLICATIONS

Number :

Filing Date :

PCT APPLICATIONS  
DESIGNATING THE U.S.

PCT Number :

PCT Filing Date :

I hereby appoint the following attorney(s) and/or agents to prosecute the

above-identified application and transact all business in the Patent and Trademark Office connected therewith.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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Full name of inventor **Anton HANS**

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                    Federal Republic of Germany

Post Office Address Same as above

43134-1

**COMBINED DECLARATION AND  
POWER OF ATTORNEY FOR PATENT APPLICATION**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below adjacent to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **METHOD FOR MANUFACTURING A SENSING ELEMENT**, and the specification of which:

- ☐ is attached hereto;
- ☐ was filed as United States Application Serial No. \_\_\_\_\_ on \_\_\_\_\_, 19\_\_ and was amended by the Preliminary Amendment filed on \_\_\_\_\_, 19\_\_.
- ☒ was filed as PCT International Application Number PCT/DE98/00525, on the 21st day of February, 1998
- ☒ an English translation of which is filed herewith.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a). I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international applications(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

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[illegible]

Page 2 of 8

above-identified application and transact all business in the Patent and Trademark Office connected therewith.

(List name(s) and registration number(s)):

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Gerard A. Messina,	Reg. No. <u>35,952</u>
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Facsimile No.: (212) 425-5288

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

1-00  
Full name of inventor Theodor GRASER

Inventor's signature [Signature] Date 1/18/99

Citizenship Federal Republic of Germany

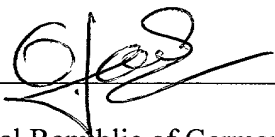
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200  
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